UNIVERSITI TEKNOLOGI MARA

AN AUTOMATED MULTIMODAL WHITE MATTER HYPERINTENSITIES IDENTIFICATION IN MRI BRAIN IMAGES USING IMAGE PROCESSING

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a panel of examiners has met on 14 February 2018 to conduct the final examination of Iza Sazanita Isa on her **Doctor of Philosophy** thesis entitled "An Automated Multimodal White Matter Hyperintensities Identification In MRI Brain Images Using Image Processing" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

White matter hyperintensities (WMH) are associated with cognitive impairment, risk of stroke and risk of dementia and a common finding in magnetic resonance imaging (MRI) images. Early detection of WMH is important for clinical analysis on effective prevention planning by medical authorities. WMH delineation on MRI images manually identified by experienced radiologists commonly uses visual score. However, the manual method is time-consuming, tedious, labour-intensive and inter-variability. Recently, research on fully automated WMH identification that aims to overcome the problems of manual delineation has attracted a lot of attention. This research proposes a method for automatic detection of WMH in white matter (WM) tissue for MRI images. A multimodal image processing which combines segmentation and enhancement procedure is proposed to process different MRI image weighted which are T2-weighted imaging (T2-WI) and fluid-attenuated inversion recovery (FLAIR). Generally, the proposed automated identification system is divided into three stages namely first, second and third stages respectively. The first stage is preprocessing procedure that combines the thresholding and filtering algorithm for pre processing the MRI images while the second stage contains two phases of main processing techniques of enhancement and segmentation. This research proposes a new enhancement technique based on the Adaptive Histogram Equalization (AHE) method. Meanwhile, the segmentation phase utilizes the two-tier segmentation to segregate brain tissues into WM, GM, CSF and WMH. A new method to initialize the clustering centers was also proposed to improve the results of segmentation. The last stage is post processing where the integration process for mapping the potential WMH obtainable from the segmentation and enhancement stage is proposed to localize the most precise WMH. In parallel, the automated performance and manual delineation for WMH identification is validated to determine the degree of similarity between both the methods. In addition, this research also proposes to classify the WMH severity based on the features of segmented WMH. In the WMH classification stage, the research considered two types of WMH features of volume and intensities to classify the severity. Finally, a software system that utilized the best of above mentioned methods is proposed to perform the automated WMH detection. Overall, the software provides good ability in identifying and classifying various loads of WMH. The software managed to achieve high capability to automatically identify WMH loads as closed as the manually delineated WMH by radiologist with more than 70% correlation. The software also showed high sensitivity on detection WMH given by TPR and PPV of 77% and 75% respectively. These findings suggest the potential use of this software as aided tool for radiologist in detecting WMH, especially to predict patients with higher risk of several chronic diseases.

TABLE OF CONTENTS